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# UNIVERSITY BULLETIN

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## UNIVERSITY OF MICHIGAN
## SUMMER SESSION

## ANNOUNCEMENT

FOR THE

# BIOLOGICAL STATION

EIGHT WEEKS, JUNE 28—AUGUST 20

SEVENTH SEASON, 1915

ANN ARBOR
PUBLISHED BY THE UNIVERSITY
1915

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# STAFF OF INSTRUCTION

Henry Allan Gleason, Ph. D., *Assistant Professor of Botany and Curator of the Phanerogamic Herbarium in the University of Michigan, Director of the Biological Station and Assistant Professor of Botany.*

Robert Wilhelm Hegner, Ph.D., *Assistant Professor of Zoology in the University of Michigan, Assistant Professor of Zoology.*

Max Mapes Ellis, Ph. D., Sc. D., *Assistant Professor of Biology in the University of Colorado, Assistant Professor of Zoology.*

Frank Caleb Gates, Ph. D., *Instructor in Botany in the University of the Philippines, Instructor in Botany.*

William Walter Cort., Ph. D., *Associate Professor of Biology in Macalester College, Instructor in Zoology.*

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Norman Asa Wood, *Curator of Birds in the Museum of the University of Michigan, Assistant in Ornithology.*

Clyde Bruce Stouffer, M.D., *Physician to the University of Michigan Health Service, Physician at the Biological Station.*

Marion Durbin Ellis, A.M., *Dean of Women.*

Frances Jewett Dunbar, A.B., *General Assistant.*

Minnie Elizabeth Watson, A.M., *Research Assistant in Zoology.*

Mary Esther Elder, A.M., *Research Assistant in Botany.*

Walter E. Rogers, A.B., *Assistant in Botany.*

Irwin Dave Simonson, A.B., *Assistant in Zoology.*

# THF BIOLOGICAL STATION OF THE UNIVERSITY OF MICHIGAN

A station for instruction and research in biology will be maintained by the University of Michigan, for the seventh season, as a part of its regular Summer Session, during the eight weeks from June 28 to August 20, inclusive, 1915.

## LOCATION.

The Station is located near the Bogardus Engineering Camp of the University on a tract of about 2,200 acres of land owned by the University and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth, and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights and makes the location favorable for hay fever sufferers.

Six miles to the west of the camp on the Grand Rapids and Indiana Railway is the nearest railway station. Pellston, a town of some 1,300 inhabitants with a bank and a variety of retail establishments. Fifteen miles to the northeast is Cheboygan on the Michigan Central Railway. A state road connects these points and passes near the station. Except for two small summer resorts on Douglas Lake the region for miles about is almost uninhabited. Douglas Lake is two and one-half miles wide and nearly four miles long. Its shores are everywhere wooded, in some places low and receding, in others rising

in terraced bluffs 70 feet above the lake. The beach is of clean sand and the sandy lake bottom slopes gradually into deep water, affording ideal conditions for bathing and boating.

The Biological Station lies in the centre of a circle of the famous summer resorts of northern Michigan. In clear view from the highest terrace of the Station and a mile and a half to the south is Burt Lake, much larger than Douglas Lake and one of the chain of lakes and rivers which form the celebrated "Inland Route" from Petoskey on Lake Michigan to Cheboygan on Lake Huron. Thousands of tourists traverse this route every summer and are charmed as the little steamer which carries them passes alternately through narrow, tortuous streams and broad stretches of open lake. Of the summer resorts on the Inland Route, Topinabee on Mullet Lake is best known and is a station of the Michigan Central Railway 8 miles from the Station.

A drive of 12 miles from the camp to the west over the state road brings one to the resort region of Petoskey, Bay View, Harbor Springs, and Harbor Point on Little Traverse Bay, while some 20 miles west of Petoskey is Charlevoix on Lake Michigan. Seventeen miles north of Pellston on the Straits of Mackinac is Mackinaw City, from which a ferry runs seven miles to Mackinac Island, in historical association and scenic beauty the gem of the Great Lakes region.

The topography of the region immediately about the Station is such as to afford a variety of floral and faunal conditions. The region is characteristically sandy and the home of the ground pines, wintergreen, and trailing arbutus, but there are areas of broad-leaf trees and shrubs with their usual accompaniments in flora and fauna. Deer and foxes occur in the neighborhood. Among forms of especial interest to zoölogists may be mentioned Lota (the fresh water codfish), Necturus (the mud puppy), the bald eagle, and the ant-lion. The flora is noted for the number of species of heaths and orchids, including several rare forms. About 650 species of flow-

ering plants are known to occur in the vicinity. A half mile south of the camp is a remarkable gorge which ends abruptly against a bluff some seventy feet high. From the bottom of the bluff there issue numerous springs which yield more than a million gallons of water a day and form a trout stream which follows the gorge to Burt Lake. This gorge is several hundred feet wide and its bottom and sides present conditions for a great variety of plants and animals, from water and bog in the stream's path through rich, moist grounds on both flanks to the dry, sandy sides of the ascent.

## PLAN OF WORK.

It is not the purpose of the Station to duplicate the work offered at the University, but to provide facilities for field work of a sort that cannot be so well carried on under urban conditions or with the limitations imposed by a university schedule. Instruction is limited to the courses announced, but qualified students may arrange to follow other lines by electing the special courses. A student may give his entire time to either botany or zoölogy or may divide it between these subjects, but no student is permitted to take the work for more than eight hours University credit. Each of the four-hour courses is planned to take one-half the student's time, the two-hour courses, one-quarter; the special courses may take any part or the whole of the time. In all courses at least half the time is spent in the field. The work of research students will be arranged in accordance with the nature of the problem selected.

## FACILITIES FOR INSTRUCTION.

The buildings of the Station include a large and commodious frame laboratory, two smaller log buildings, a tent laboratory, and an aquarium shelter. These are comfortably fitted with the necessary furniture, and are used for recitations, laboratory work, offices, and research. The

equipment of the Station includes a large launch, two portable rowboat motors, five rowboats, various types of nets and seines, traps, cameras, field glasses, compound and dissecting microscopes and accessories, microtome, and a large supply of minor articles. A good working library is provided. Students expecting to use unusual types of apparatus in their research are invited to correspond with the Director, who will give his attention to their needs.

## GRADUATE WORK.

Graduate students, when regularly matriculated in the University and properly registered with the Dean of the Graduate Department, may carry on work at the Station which will count toward an advanced degree.

For full information concerning the requirements for advanced degrees, address the Dean of the Graduate Department, Ann Arbor, Michigan.

## BOARD AND LODGING.

Tents for the use of the students and teaching staff are pitched near the Station buildings. Each is erected over a permanent frame, and is waterproof and stormproof. Each tent, 14x14 ft., accommodates a maximum of four persons and is covered by a fly, provided with a wooden floor, and equipped with mosquito bed-canopies, pail, tub, washstand, pitcher, bowl, table, chairs, and straw-filled bed ticks. Kerosene stoves will be supplied if needed. Students will provide their own towels and bedding, and those who prefer to do so may bring their own tents. Such tents must be pitched in accordance with the regulations of the Station and will be subject to daily inspection.

Mrs. Marion D. Ellis, Dean of Women, has general supervision of the women's quarters, and is ready at any time to advise women students.

Table board is provided at the mess tent of the Station on the cooperative plan, and members of the Station are not permitted to cook their own meals.

## FEES AND EXPENSES.

Students, except as below, will pay the regular Summer Session fee of $21.00 for the eight weeks and will then be entitled to take courses aggregating eight hours university credit. A charge of $8.00 is made for the use of the scientific equipment. A further charge of $8.00 is made to those students who use the tents provided by the Station. Students may, however, provide their own camp equipment, of such sort as they may choose. Board at the Mess Tent of the Station is provided at cost, about $4.25 per week.

Students not graduates of the University of Michigan who enroll in the Graduate Department will pay, in place of the above fee of $21.00, a fee of $26.00. This fee of $26.00 includes the regular matriculation fee of the University and the fee for the current summer session.

All members of the Station are entitled to free medical advice and attendance. Dr. C. B. Stouffer of the staff of the University Health Service will be in residence at the Station during the session.

Low round-trip rates from any point in the United States to Pellston or Mackinac Island may be purchased over all railroads and are good for the summer season.

The total expense for a student from Ann Arbor will be about ninety dollars. For others the amount will be larger or smaller, depending on the distance.

## REGISTRATION.

Since the number of students that can be accommodated is limited, *immediate registration is necessary to insure admission.* Applications for admission should be addressed to Professor H. A. Gleason, Ann Arbor, Michigan, and should indicate the courses that the student intends to pursue, his preparation for them, and whether he will bring his own camp equipment or use that provided by the Station. Inquiries concerning the instruction, equipment, or research at the Station may be ad-

dressed to the Director, to the Dean of Women, Mrs. Marion D. Ellis, Boulder, Colorado, or to the instructor in charge of the course.

## PHOTOGRAPHY.

While no formal course in photography is offered, the camera is used in class work in many courses, and the student has an excellent opportunity to become familiar with the methods and uses of photography for scientific work. A well equipped dark-room is provided and may be used by students. The station is provided with a camera of the usual type, and a reflecting camera. Although students may use the station apparatus for scientific purposes, they should bring their own cameras for other uses. Those exceeding 5x7 size are not suitable for the field, and the best is probably 4x5, or post-card size. Daylight developing outfits for films are preferred. The student should bring enough films or plates to last the whole season.

## NATURE STUDY.

No formal instruction is given in the subject matter of nature study, but it is the purpose of the station to bring the student into the closest possible contact with out-door nature. It is believed that teachers of nature study will find this the best preparation.

## MEDICAL ATTENDANCE.

No serious illness has yet occurred among students at the station and none is expected. A physician is in residence at the camp and his services are free to students.

## EXCURSIONS: CAMPING PARTIES.

Some practical experience with woodcraft and camping is considered not merely desirable, but almost essential to the field naturalist. To this end, students are encouraged to arrange Saturday excursions to the points of scientific and scenic interest that lie on every side.

Such excursions afford opportunities to the student to broaden his knowledge of natural history and to collect scientific specimens. Excursions to nearer points by boat and on foot form a regular part of the work of the Station. Camping parties may be sent out each week end and an opportunity is afforded every student to join one. On them, instruction in camping, cooking, and woodcraft is given by an experienced person.

## RECREATION.

Recreation is not permitted to interfere with the regular work of the Station, but when the day's work is done, opportunities for boating, swimming, and fishing are to be found on every side. The location of the Station in the midst of the northern wilderness and within the circle of Northern Michigan resorts makes it possible to *combine with study the pleasures of a summer outing in an invigorating climate.* At the close of each of the previous sessions every student testified that, while he had gained in his studies as much as would have been possible at a regular university seat, he had at the same time improved in health. Many who had come to the Station jaded by a year of teaching left it as much rested as though they had given the whole time to recreation alone.

## PUBLICATION.

The instruction offered is along the lines of the published researches of the members of the teaching staff, and students will receive every encouragement to take up work that may yield results suitable for publication. Every assistance will be given in preparing matter for publication and in placing it in suitable scientific journals.

## SUPPLEMENTARY ANNOUNCEMENT.

A supplementary bulletin gives detailed information concerning the necessary equipment, including clothing, books, and scientific equipment, the best route to the

Station, the method of registration, the cooperative mess arrangements, and many other matters of interest to prospective students at the Station. A copy will be sent to any address upon application to the Director of the Station.

## COURSES OF INSTRUCTION.

Each course occupies the entire working day assigned to it, and consists of field or laboratory work, supplemented in every case by lectures, recitations, or conferences, and by assigned reading and preparation of reports.

### ZOOLOGY.

1. *The Natural History of Vertebrate Animals.*— The course deals chiefly with fishes, amphibians, and reptiles, not with birds (see Course 3), and only incidentally with mammals. As far as possible, all forms occurring in the region are collected, identified, and their habits studied in both field and laboratory. Students thus learn to recognize many of the native vertebrates at sight. In the field special attention is given to methods of work, and the records made form the basis of reports and conferences. The general problems of animal ecology, species behavior, evolution and taxonomy are considered as shown by the field data. Although most of the work is given in the field, attention to precise methods of observation and to the correct use of data is required.

Thursday. *Two hours credit.* Assistant Professor ELLIS.

*Prerequisite*: Elementary collegiate zoölogy.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 1a.

2. *The Natural History of Invertebrate Animals.*— The protozoans, sponges, coelenterates, rotifers, bryozoans, worms, crustaceans, and molluscs of the region are studied. Both aquatic and terrestrial invertebrate

animals are collected and identified, so that students will gain a general familiarity with them and learn to recognize the common species at sight. The principles of fresh water biology are especially emphasized. Attention is given to exact methods of field observations and the making of field records. The field work is supplemented by a more detailed examination of animals in the laboratory; here the adaptations which make certain organisms suited to particular habitats are studied. In the conferences, the relation of observations to general problems is discussed. This course attempts to give an intimate knowledge of outdoor life, to make one at home with invertebrates in the field.

Wednesday and Friday. *Four hours credit.* Assistant Professor HEGNER.

*Prerequisite*: Elementary collegiate zoölogy.

This course gives two hours credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 2a.

3. *The Natural History of Birds.*—Birds are studied with especial reference to their environment. The field work includes identification by eye and ear, observations on habitat preferences, food habits, nesting activities, and the early autumnal migration movements. In the conferences attention is given to the position of birds in the animal kingdom, some of the adaptations to particular modes of life, their economic relations, and the facts and theories of their distribution and annual migration movements. The bird fauna is abundant and the opportunities for the study of some of the northern species are especially good.

Saturday morning, and two or three early morning trips to be arranged. *Two hours credit.* Mr. WOOD.

*No prerequisite.*

This course does not give credit to graduate students.

4. *The Natural History of Insects.*—This course is intended to give the student a general acquaintance with the insects of the region and to afford opportunity for the study of the various forms in their native habitats. Field

studies are made of the life histories, habits, and activities of insects belonging to various orders. Emphasis is placed upon the relation of insects to their environment, and their economic relations are also considered. Some work on the morphology and physiology of insects is included. Instruction is given in the approved methods of collecting and preserving insects in all stages of development. Opportunity is afforded to form individual collections of properly determined specimens. Familiarity with the entomological literature is encouraged.

Monday. *Two hours credit.* Assistant Professor Ellis.

*Prerequisite*: Elementary collegiate zoology.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 4a.

6. *Special and Research Work in Zoölogy.*—This course does not involve formal instruction, but is intended for those who wish to take up special work or to do research work under direction. Students qualified to work independently may choose problems to meet their individual needs. Such students register under Dr. Ellis, who has general supervision of zoölogical research. Students who are beginning research, or who work under direction are recommended to choose subjects in the following fields:

a. *The Fishes or Insects.* Assistant Professor Ellis.
b. *The Arthropods.* Assistant Professor Hegner.
c. *The Parasitic Worms.* Dr. Cort.

Days to be arranged. *Two, four, six, or eight hours credit.*

This course gives full credit to graduate students.

GENERAL ZOOLOGY

7. This course is adapted to students who have had no training in zoölogy. It consists of lectures, laboratory work, and field observations. The object is to give the student a thorough scientific training, together with information concerning the essential facts and fundamental principles of animal life. The laboratory work consists

of a study of types representing the most important phyla in the animal kingdom. The animals are studied from the standpoint of structure, function, and development, and the student is given opportunity to study the habits and activities of animals in the various groups. In the field, emphasis is laid upon the relation of animals to their environment. The student is trained in independent observation, becomes acquainted with methods of study both in the laboratory and in the field, and obtains information which will serve as a foundation for advanced zoölogical courses.

Wednesday and Friday. *Four hours credit.* Dr. Cort. *No prerequisite.*

This course does not give credit to graduate students. Taken together, this course and Botany 1 offer eight hours work in biology, open to all students without prerequisite, and substantially equivalent to General Biology at the University.

## BOTANY.

1. *Field and Forest Botany.*—The work of this course is designed to give the student a general familiarity with the plant life of the region, with the names and habits of the commoner species, and with the correlation between their habits and structure. The work consists chiefly of field trips, supplemented by laboratory exercises and lectures. In the field the student becomes familiar with the trees, the shrubs, the aquatics, the ferns, the insectivorous plants, the orchids, and some of the herbaceous plants of the region, and with the plant associations in which they grow. The effect on the vegetation of certain external factors, such as soil, water, and light, the adaptation of plants to winter conditions, the cross pollination of flowers by insects, the dissemination of seeds, and other similar subjects are demonstrated. In the laboratory a study is made of the structure of some plants, with chief attention to the relation between the form of the plant and the environment in which it lives.

Tuesday and Thursday. *Four hours credit.* Mr. McFarland.

*No prerequisite.*

This course does not give credit to graduate students. It is accepted at the University in lieu of Botany 1 and 2 as a prerequisite to advanced courses in botany. This course and Zoölogy 7, taken together, offer eight hours work in biology, open to all students without prerequisite, and substantially equivalent to General Biology at the University.

2. *Systematic Botany.*—The chief aim of this course is to acquaint the student with the flora about the Station and to give him facility in the identification of plants by the Manual. About one hundred species of plants are identified in the field, the characteristics of the more important families of flowering plants are learned, and the general principles of the classification of plants are presented. There is excellent opportunity for the collection and preparation of material for the herbarium. Students who complete this course successfully should be able to identify readily the native flora in any section of the country.

Wednesday. *Two hours credit.* Dr. Gates.

*Prerequisite*: Elementary collegiate botany.

This course gives one hour credit to graduate students.

3. *Ecology.*—This course serves as a general introduction to ecological field work and the methods of ecological research, with particular reference to the study of plant associations. Practice is given in the recognition of associations, the determination and description of their structure and successional relations, and the measurement of some environmental factors. Particular attention is given to the dynamic factors of the environment, to their effect on the present structure and future development of the plant community, and to the role of the individual plant in promoting or retarding these effects. Because of the large number of associations in the region, it is impossible to study more than the most

important ones. These include the aspen association, the hardwood forest, the tamarack and sphagnum bog, the arbor-vitae bog, and the sand dunes, lagoons, and beaches along the lake shore.

Tuesday and Thursday. *Four hours credit.* Assistant Professor GLEASON and Dr. GATES.

*Prerequisite*: Course 2 at the Station, or Course 26 or 22 at the University, or graduate standing.

This Course gives full credit to graduate students.

4. *Special and Research Work in Botany.*—Students who have taken Courses 2 or 3, or have had adequate botanical experience elsewhere, will find at the Biological Station excellent opportunities for further study or research in many lines of botany. Undergraduates, or graduates beginning research and consequently needing personal direction, are advised to choose a problem along ecological or systematic lines. Advanced students or independent investigators are free to choose problems in any line of botany, and every effort is made to provide them with the necessary facilities and equipment for their work.

Days to be arranged. *Two, four, six, or eight hours credit.* Assistant Professor GLEASON and Dr. GATES.

*Prerequisite*: Admission only by arrangement with the instructors in charge.

This course gives full credit to graduate students.

5. *Plant Anatomy.*—The general facts and principles of plant anatomy are presented by material collected and prepared by each student individually. Students thus have practice in the preservation of material, methods of fixation, section cutting, and staining. Every facility will be given for the collection of material for use in teaching or in research. The topics chiefly considered are the anatomy and secondary thickening of the stem, the structure of the foliage leaf, and its modifications in different environments.

Monday. *Two hours credit.* Assistant Professor GLEASON and Mr. ROGERS.

*Prerequisite*: Elementary collegiate botany.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 5a.

6. *Advanced Systematic Botany.*—In the field, the student will have practice in the identification and recognition of plants belonging to the more difficult groups, including grasses, sedges, pondweeds, and others, and in the identification of plants from fruit or leaf characters only. The characteristics of these families will be presented both in the field and by lecture. The lectures will also consider the evolution and relationships of the angiosperms, the rules of botanical nomenclature, and the present trend of systematic botany.

Friday. *Two hours credit.* Dr. GATES.

*Prerequisite*: Botany 2 at the Station, or Botany 22 at the University, or equivalent preparation elsewhere.

This course gives full credit to graduate students.

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THE UNIVERSITY BULLETIN IS ISSUED BY THE UNIVERSITY OF MICHIGAN AS OFTEN AS EVERY SIX WEEKS DURING THE UNIVERSITY YEAR.

ENTERED AS SECOND-CLASS MATTER AT THE POSTOFFICE AT ANN ARBOR, MICHIGAN.

THE BULLETIN INCLUDES THE FOLLOWING PUBLICATIONS:—

The Annual Report of the President.

The Calendar of the University.

The Annual Announcements of the Departments of Literature, Science, and the Arts, of Engineering and Architecture, of Medicine and Surgery, and of Law, the School of Pharmacy, the Homœopathic Medical College, the College of Dental Surgery, the Graduate Department, and the Summer Session.

Other Announcements of the several departments of instruction, Reports of University officers, etc.

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UNIVERSITY BULLETIN
NEW SERIES, VOL. XVII, NO. 25. FEBRUARY, 1916

# UNIVERSITY OF MICHIGAN SUMMER SESSION

## ANNOUNCEMENT

FOR THE

# BIOLOGICAL STATION

EIGHT WEEKS, JULY 3—AUGUST 25

EIGHTH SEASON, 1916

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# STAFF

OTTO CHARLES GLASER, Ph.D., *Associate Professor of Zoology in the University of Michigan, Director of the Biological Station, and Associate Professor of Zoology.*

REUBEN MYRON STRONG, Ph.D., *Professor of Anatomy in the University of Mississippi, Professor of Zoology.*

MAX MAPES ELLIS, Ph.D., Sc.D., *Assistant Professor of Biology in the University of Colorado, Assistant Professor of Zoology.*

FRANK CALEB GATES, Ph.D., *Sometime Instructor in Botany in the University of the Philippines, Assistant Professor of Botany.*

JOHN HENRY EHLERS, Ph.D., *Instructor in Botany in the University of Michigan, Instructor in Botany.*

RICHARD MORRIS HOLMAN, Ph.D., *Instructor in Botany in the University of Michigan, Instructor in Botany.*

CLYDE BRUCE STOUFFER, M.D., *Physician to the University of Michigan Health Service, Physician to the Biological Station.*

MARION DURBIN ELLIS, A.M., *Dean of Women.*

FRANCES JEWETT DUNBAR, A.B., *Curator.*

WILLIAM WALTER CORT, Ph.D., *Associate Professor of Biology in Macalester College, Research Assistant in Zoology.*

RUBY M. HALL, *Research Assistant in Botany.*

MARGARET REYNOLDS, *Assistant in Zoology.*

FRANK B. COTNER, A.B., *Assistant in Botany.*

# The Biological Station of the University of Michigan

A station for instruction and research in biology will be maintained by the University of Michigan, for the eighth season, as a part of its regular Summer Session, during the eight weeks from July 3 to August 25, inclusive, 1916.

## LOCATION.

The Station is located near the Engineering Camp of the University on a tract of about 2,200 acres of land owned by the University and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth, and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights.*

Six miles to the west of the camp on the Grand Rapids and Indiana Railway is the nearest railroad station, Pellston, a town of some 1,300 inhabitants, with a bank and a variety of retail establishments. Topinabee, on the Michigan Central Railway, is 8 miles from the camp. Fifteen miles to the northeast, also on the Michigan Central Railway, is Cheboygan. A state road connects these points and passes near the laboratory. Except for two small summer resorts on Douglas Lake the region for miles about is almost uninhabited. Douglas Lake is two and one-half miles wide and nearly four miles long. Its shores are everywhere wooded, in some places low and receding, in others rising in terraced bluffs 70 feet in height. The beach is of clean sand and the lake bottom slopes gradually into deep water.

The topography immediately about the Station is such as to afford a variety of floral and faunal conditions. The region is characteristically sandy and the home of ground pines, wintergreen, and

* During the past two seasons the total rainfall has been between three and four inches each year. The average temperature for July has been 69° and for August 66°. The average daily maximum does not exceed 80°, and the minimum frequently drops to 45° during the night. The general proportion of pleasant days is so high that field work is seldom interrupted.

trailing arbutus, but there are areas of broad-leaf trees and shrubs. About 650 species of flowering plants are known to occur in the vicinity. A half mile south of the camp is a remarkable gorge ending abruptly against a high bluff, from the bottom of which issue numerous springs that yield more than a million gallons of water a day and form a trout stream following the gorge to Burt Lake. This gorge is several hundred feet wide and its bottom and sides present conditions for a great variety of plants and animals.

Although faunistic studies in this region have hardly begun and no records are available for several of the larger groups, the fauna, as listed, includes some 370 species representing practically every phylum in the animal kingdom.

## GENERAL LIVING CONDITIONS.

At a station of this character the general conditions of living are necessarily somewhat unique. However, reasonable comfort, and especially health, are carefully provided for.

**Board and Lodging.**—Tents for the use of the students and staff are pitched near the Station buildings. Each is erected over a permanent frame, and is waterproof, stormproof, and comfortable. Each tent, 14 x 14 ft., accommodates a maximum of four persons and is covered by a fly, provided with a wooden floor, and equipped with mosquito bed-canopies, pail, tub, washstand, pitcher, bowl, table, chairs, lantern, and straw-filled mattresses. Stoves will be supplied if needed. Students will provide their own towels and bedding, and those who prefer to do so may bring their own tents. Such tents must be pitched in accordance with the regulations of the Station and all will be subject to inspection.

Space in tents is allotted in advance upon receipt of the reservation fee of eight dollars, or after registration. The attempt is made to place congenial people together. Students will find the tents ready for occupancy, but are expected to care for them personally during the session.

Mrs. Max M. Ellis, Dean of Women, has general supervision of the women's quarters, and is ready at any time to advise women students.

Board at the Station is furnished on the coöperative plan, under the direction of a stewardess approved by the University. She purchases all the supplies, plans the daily menu, and has general supervision of the kitchen and mess tent. It is planned to furnish board at about $4.25 per week. Members of the Station are not permitted to cook their own meals.*

* In order to make possible the purchase of supplies at low cash prices, each member of the Station must, on arrival, deposit with the stewardess thirty-five dollars in cash or draft. Students leaving before the close of the session will receive full rebate of their unexpended portion, and all excess will be returned to others at the close of the season.

**Health.**—Although the climate and particularly the outdoor life are highly invigorating and conducive to health, nevertheless, should the need arise, any member of the station is entitled to medical attention, without charge, by the staff physician who also inspects and regulates matters pertaining to general sanitation.

The drinking water is entirely safe.

**Recreation.**—After the day's work, opportunities for boating, swimming, and fishing, are within easy reach. Bonfires on the beach and other informal gatherings after supper have proved to be popular diversions. One of the buildings is set aside for social purposes on inclement evenings, although the other laboratories are reserved for those who wish to work. There is no class-work on Saturday afternoons.

## FACILITIES FOR INSTRUCTION AND RESEARCH.

The buildings of the Station include a large and commodious frame laboratory, two smaller log buildings, a tent laboratory, and an aquarium shelter. These are comfortably fitted with the necessary furniture, and are used for recitations, laboratory work, offices, and research. The equipment of the Station includes a large launch, two portable rowboat motors, five rowboats, various types of nets and seines, traps, cameras, field glasses, compound and dissecting microscopes and accessories, microtome, and a large supply of minor articles. A good working library is provided. Students expecting to use unusual types of apparatus in their research are invited to correspond with the Director, who will give his attention to their needs.

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Students not graduates of the University of Michigan who enroll in the Graduate Department will pay, in place of the above fee of $21.00, a fee of $26.00. This fee of $26.00 includes the regular matriculation fee of the University and the fee for the current summer session.

## APPLICATION AND REGISTRATION.*

Since the total number of students that can be accommodated is limited, *immediate application is necessary to insure admission.* Moreover, as efficient field work can be accomplished only with small numbers, it is desired to limit the students in each class to twelve, although this number may be exceeded if absolutely necessary. Inasmuch as students will be received into these courses in the order of application, it is advisable to notify the Director or the several instructors as early as possible.

The courses are given chiefly in the field and for this reason it is impracticable to make changes in the schedule as announced. Students enrolled in the research courses do their work on the most convenient days.

Registration blanks will be filled by each student after arrival at the Station. Students from other institutions may arrange for a transfer of credits through the Director and the Registrar of the University.

## COURSES FOR UNDERGRADUATES AND GRADUATES.

It is not the purpose of the Station to duplicate the work offered at the University, but to provide facilities for field work of a sort that cannot be so well carried on under urban conditions or with the restrictions imposed by a university schedule. Instruction is limited to the courses announced, but qualified students may arrange to follow other lines by electing the special courses. A student may give his entire time to either botany or zoölogy or may divide it between these subjects, but no student is permitted to take work for more than eight hours University credit. Each of the four-hour courses is planned to occupy one-half the student's time, the two-hour courses, one-quarter; the special courses may take the whole or any part of the time. In all courses at least half the time is spent in the field. The work of research students will be arranged in accordance with the nature of the problem selected.

Each course occupies the entire working day assigned to it, and consists of field or laboratory work, supplemented in every case by lectures, recitations, or conferences, and by assigned reading and preparation of reports.

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* A supplementary announcement, to be had upon application to the Director, gives detailed information concerning the necessary equipment, scientific and personal, the best route to the Station, and other matters not specifically dealt with in the present bulletin.

Graduate students, when regularly matriculated in the University and properly registered with the Dean of the Graduate Department, may carry on work at the Station which will count toward an advanced degree.

For full information concerning the requirements for advanced degrees, address the Dean of the Graduate Department, Ann Arbor, Michigan.

## Zoology.

101. *The Natural History of Vertebrate Animals.*—The course deals chiefly with fishes, amphibians, and reptiles, not with birds (see Course 107), and only incidentally with mammals. As far as possible, all forms occurring in the region are collected, identified, and their habits studied in both field and laboratory. Students thus learn to recognize many of the native vertebrates at sight. In the field special attention is given to methods of work. The general problems of animal ecology, species behavior, evolution and taxonomy are considered as shown by the field data. Although most of the work is given in the field, attention to precise methods of observation and to the correct use of data is required.

Thursday. *Two hours credit.* Assistant Professor ELLIS.
*Prerequisite*: Elementary collegiate zoölogy.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 101*a*.

103. *The Natural History of Invertebrate Animals.*—A study of the natural history of the aquatic invertebrates occurring in Douglas Lake. This will involve the collection and identification of forms, the determination of their life histories and of the adaptations and environmental factors decisive in the matters of distribution and survival. The class as a whole will carry through a definite program but each member will be responsible for the data on a particular group of organisms to be presented at the end of the course in the form of a careful detailed report. In addition the student will have actual experience in the determination of depths, temperatures, transparency to light, dissolved substances, food-content of the water, and such other matters as fall within the scope of an analysis of the lake as a medium for life. By means of the lectures and conferences, the whole of the material collected will be correlated so that at the end of the season each student will have a fairly comprehensive picture of the conditions of life in an inland lake, and also some special knowledge of some one group as affected by these conditions.

Wednesday and Friday. *Four hours credit.* Professor GLASER.
*Prerequisite*: Elementary collegiate zoölogy.

This course gives two hours credit to graduates, who may obtain full credit by registration in Course 103*a*.

105. *The Natural History of Insects.*—This course is intended to give the student a general acquaintance with the insects of the region and to afford opportunity for the study of the various forms in their native habitats. Field studies are made of the life histories, habits, and activities of insects belonging to various orders. Emphasis is placed upon the relation of insects to their environment. Their economic relations are also considered. Some work on the morphology and physiology of insects is included. Instruction is given in the approved methods of collecting and preserving insects in all stages of development. Opportunity is afforded to form individual collections of properly determined specimens. Familiarity with the entomological literature is encouraged.

Monday. *Two hours credit.* Assistant Professor ELLIS.
*Prerequisite*: Elementary collegiate zoölogy.

This course gives two hours credit to graduates. Students desiring full credit, must complete extra work, and will register for Course 105*a*.

107. *The Natural History of Birds.*—Special attention given to methods of field work. The course, treating of birds with particular reference to their environment, includes identification by eye and ear, observations on habitat preferences, food habits, nesting activities, and the early autumnal migration movements. In the conferences illustrated by lantern slides, attention is given to the position of birds in the animal kingdom, some of the adaptations to particular modes of life, their economic relations, and the facts and theories of their distribution and annual migration movements. The bird fauna is abundant and the opportunities for the study of some of the northern species are especially good.

Saturday morning, and two or three early morning trips to be arranged. *Two hours credit.* Professor STRONG.

*No prerequisite.*

Course 107 does not give credit to graduates. Those who desire credit, or who wish to carry on further work on birds, may elect either 107*a* or Course 109 with Professor STRONG.

109. *Special and Research Work in Zoölogy.*—Students who do not find under the formally announced courses in zoölogy, work suited to their needs or attainments, may, if properly prepared, elect Course 109. Those qualified to work independently will find numerous problems to engage their attention, or will be guided along the lines of interest represented by the several members of the staff, and indicated in the courses formally announced. Every encouragement in the direction of profitable research and the publication of results will

be given. Advanced students as well as independent investigators who can foresee special needs are advised to notify the Director who will endeavor to provide the necessary facilities.

Days to be arranged. *Two, four, six, or eight hours credit.* Professor GLASER, Professor STRONG, Assistant Professor ELLIS, and Dr. CORT.

This course gives full credit to graduates.

## Botany.

102. *Field and Forest Botany.*—The work of this course is designed to acquaint the students with the structure and habits of the principal groups of plants as illustrated by representatives collected in the field by the students themselves. The student becomes familiar with the names and habits of the commoner species. The work consists principally of field trips which are supplemented by laboratory exercises and lectures. The class studies the trees, the shrubs, the aquatics, the ferns, the insectivorous plants, the orchids and some of the herbaceous plants of the region and the effects of external factors, such as soil, water, and light upon the vegetation. The adaptation of plants to winter conditions, the cross pollination of flowers by insects, the metamorphosis of plant organs, the dissemination of seeds and other similar subjects are demonstrated. In connection with this course opportunity will be afforded college and high school teachers of botany to collect material for use in their classes. Instruction in the preservation of such material will be given to students desiring it.

Tuesday and Thursday. *Four hours credit.* Dr. HOLMAN.

*No prerequisite.*

This course does not give credit to graduate students. It is accepted at the University in lieu of Botany 1 and 2 as a prerequisite to advanced courses in botany.

104. *Systematic Botany.*—The chief aim of this course is to acquaint the student with the flora about the Station and to give him facility in the identification of plants by the Manual. About one hundred species of plants are identified in the field, the characteristics of the more important families of flowering plants are learned, and the general principles of the classification of plants are presented. There is excellent opportunity for the collection and preparation of material for the herbarium. Students who complete this course successfully should be able to identify readily the native flora in any section of the country.

Wednesday. *Two hours credit.* Dr. EHLERS.

This course gives one hour credit to graduate students.

106. *Ecology.*—This course serves as a general introduction to ecological field work and the methods of ecological research, with particular reference to the study of plant associations. Practice is given in the recognition of associations, the determination and description of their structure and successful relations, and the measurement of some environmental factors. Particular attention is given to the dynamic factors of the environment, to their effect on the present structure and future development of the plant community, and to the role of the individual plant in promoting or retarding these effects. Because of the large number of associations in the region, it is impossible to study more than the most important ones. These include the aspen association, the hardwood forest, the tamarack and sphagnum bog, the arbor-vitae bog, and the sand dunes, lagoons, and beaches along the lake shore.

Tuesday and Thursday. *Four hours credit.* Assistant Professor GATES.

*Prerequisite*: Course 104 at the Station, or Course 26 or 22 at the University, or graduate standing.

This course gives full credit to graduate students.

108. *Plant Anatomy.*—The general facts and principles of plant anatomy are presented by means of material collected and prepared by each student individually. Students thus have practice in the preservation of material, methods of fixation, section cutting, and staining. Every facility will be given for the collection and preservation of material for use in teaching or in research. The topics chiefly considered are the anatomy and secondary thickening of the stem and the structure of the root and the foliage leaf. The modifications of the structure of the leaf in different environments will be considered.

Monday. *Two hours credit.* Dr. HOLMAN, and Assistant.

*Prerequisite*: Elementary collegiate botany.

110. *Advanced Systematic Botany.*—In the field, the student will have practice in the identification and recognition of plants belonging to the more difficult groups, including grasses, sedges, pondweeds, and others, and in the identification of plants from fruit or leaf characters only. The characteristics of these families will be presented both in the field and by lecture. The lectures will also consider the evolution and relationships of the angiosperms, the rules of botanical nomenclature, and the present trend of systematic botany.

Friday. *Two hours credit.* Dr. EHLERS.

*Prerequisite*: Botany 104 at the Station, or Botany 22 at the University, or equivalent preparation elsewhere.

This course gives full credit to graduate students.

112. *Special and Research Work in Botany.*—Students who have taken Courses 104 or 106 or have had adequate botanical experience elsewhere, will find at the Biological Station excellent opportunities for further study or research in many lines of botany. Undergraduates, or graduates beginning research and consequently needing personal direction, are advised to choose a problem along ecological or systematic lines. Advanced students or independent investigators are free to choose problems in any line of botany, and every effort is made to provide them with the necessary facilities and equipment for their work.

Days to be arranged. *Two, four, six, or eight hours credit.* Assistant Professor GATES, Dr. HOLMAN, and Dr. EHLERS.

*Prerequisite*: Admission only by arrangement with the instructors in charge.

This course gives full credit to graduate students.

THE UNIVERSITY BULLETIN IS ISSUED BY THE UNIVERSITY OF MICHIGAN AS OFTEN AS EVERY SIX WEEKS DURING THE UNIVERSITY YEAR.

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THE BULLETIN INCLUDES THE FOLLOWING PUBLICATIONS:—

The Annual Report of the President.
The Catalogue of the University.
The Annual Announcements of the College of Literature, Science, and the Arts, the Colleges of Engineering and Architecture, the Medical School, the Law School, the College of Pharmacy, the Homœopathic Medical School, the College of Dental Surgery, the Graduate School, and the Summer Session.
Other Announcements of the several departments of instruction, Reports of University officers, etc.

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1917

# UNIVERSITY BULLETIN

NEW SERIES, VOL. XVIII, NO. 26. MARCH, 1917

## UNIVERSITY OF MICHIGAN
## SUMMER SESSION

## ANNOUNCEMENT

FOR THE

# BIOLOGICAL STATION

EIGHT WEEKS, JULY 2—AUGUST 24

NINTH SEASON, 1917

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1917

# STAFF

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JOHN HENRY EHLERS, Ph.D., *Instructor in Botany in the University of Michigan, Instructor in Botany.*

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ERNEST REED, *Assistant in Botany.*

# The Biological Station of the University of Michigan

A station for instruction and research in biology will be maintained by the University of Michigan, for the ninth season, as a part of its regular Summer Session, during the eight weeks from July 2 to August 24, inclusive, 1917.

## LOCATION

The Station is located near the Engineering Camp of the University on a tract of about 3060 acres of land owned by the University and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth, and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights.*

Six miles to the west of the camp on the Grand Rapids and Indiana Railway is the nearest railroad station, Pellston, a town of some 1,300 inhabitants, with a bank and a variety of retail establishments. Topinabee, on the Michigan Central Railway, is 8 miles from the camp. Fifteen miles to the northeast, also on the Michigan Central Railway, is Cheboygan. A state road connects these points and passes near the laboratory. Except for two small summer resorts on Douglas Lake the region for miles about is almost uninhabited. Douglas Lake is two and one-half miles wide and nearly four miles long. Its shores are everywhere wooded, in some places low and receding, in others rising in terraced bluffs 70 feet in height. The beach is of clean sand and the lake bottom slopes gradually into deep water.

* During the seasons of 1914 and 1915 the total rainfall was between three and four inches each year. The average temperature for July has been 69° and for August 66°. The average daily maximum does not exceed 80°, and the minimum frequently drops to 45° during the night. The general proportion of pleasant days is so high that field work is seldom interrupted. During the past season the temperature was considerably higher than usual, as was also the case throughout the United States, but the nights were cool and the usual course of laboratory and field work was not interfered with.

## OPPORTUNITIES FOR BIOLOGICAL WORK

The opportunities for biological work in the Douglas Lake region are well stated in the report of Professor O. C. GLASER, director of the Biological Station for the session 1916, which is based in part on statements from members of the instructional staff associated with him. From this report the following sections are quoted:

"Among the more vital and promising tendencies in modern biology is the movement toward ecological analysis. Ecology is the science which deals broadly with the economy of living things. It involves the study of life-histories of races and individuals; it deals with the sum total of interplay between organisms and the conditions under which they live. It deals intensively with questions of behavior and reaction."

That the Douglas Lake region furnishes ample material for this type of study is pointed out by Professor GLASER thus: "There are many species of fish and the aquatic fauna is by no means limited to these vertebrates. Quite apart from the amphibians fringing the shore, and forms more or less dependent on the lake for supplies, the invertebrate world is well represented, both in numbers and, to some extent, variety, by the larger crustacea, by clams, snails, and at times by countless examples of the fresh water hydra. Bryozoans and sponges are frequent but variable in occurrence.

"In two respects the waters of Douglas Lake are quite astounding. Parasitism is rampant. Then too, there are periods when the free floating life, the plankton, composed of scarcely visible as well as quite microscopic vegetable and animal organisms is so dense that it quite transcends belief. It is true that here again the variety of forms is not the greatest, but numerically those present could hardly be found more highly concentrated anywhere. Certainly there is an abundance of this sort of material for teaching and research.

"Since ecology considers the reciprocal relations between living things and their conditions of life, it follows that these too are available for study and research. The physiographic, geological, climatological, the physical and chemical conditions of the lake are no less varied, interesting, and significant than those of similar lakes elsewhere. Physiographically and geologically the region is unstable. This alone opens up large possibilities. Important problems also present themselves owing to the great inequalities of depth. From shallow water, with bottom clearly visible, one may pass instantly into regions ranging from forty to eighty feet in depth. The sudden differences in light, temperature, gas content, and other circumstances of life, occasioned by these sudden transitions are naturally great. Added to this, Douglas Lake presents other conditions somewhat unique. Surface intake and outgo are practically limited to evaporation and three widely separated but small streams. These, however, do not exhaust the possibilities of aqueous metabolism. Whether or not there are bottom springs may be an open question; that there are

bottom outlets is proved. Carp Creek is supplied from Douglas Lake in this manner.

"Thorough analysis of the waters from every angle having biological bearings together with the comparative studies made by Doctor Ellis on neighboring lakes and rivers will prove to be of great scientific and economic value. Some of the problems which suggest themselves in connection with pearl mussels and fishes have an immediate practical bearing.

"Finally, there is also a terrestrial fauna to be reckoned with. Insects of all sorts are abundant. Mammals are not common. With respect to birds, Doctor R. M. Strong makes the following statement:

'The bird life is not so rich about the Station as at some places, nevertheless, the location has important ornithological attractions. A number of species breed here which are known to the majority of ornithologists only as migrants.

'There are densely wooded bogs, hardwood forests, extensive aspen areas, settlements, meadows, and roadsides, all available in a single half-day trip. Field trips can be arranged which will furnish enough birds to keep a class profitably occupied if the material is properly used.

'Research problems may be taken up to advantage. Behavior studies in the field and with captive birds are practicable. Certain types of ecological work are also feasible. Intensive studies of single pairs of breeding birds both during and after the nesting period are desirable. Much can be done on the life histories of certain species which do not breed farther south and are not well known'."

Concerning the possibilities of work on parasites of animals Doctor W. W. Cort who has spent several summers at the Station reports as follows:

"Douglas Lake is an excellent place to study parasites. The lake is small enough to give a ready access to the host animals. Studies and collections have already shown that there is an abundance of material waiting to be worked up. The fact that twenty different kinds of larval trematodes could be collected from the lake when not even all the hosts available were examined shows what a wealth of material of this group is present. When it is considered that these larval forms are new and for not one of them is the adult stage definitely known, some idea can be gained of the numbers of problems which are waiting solution. Of the cestodes, nematodes and acanthocephala of the region even less is known. The nearness to Burt Lake and the fish and birds of the Great Lakes increases the variety of possible host animals.. From all aspects the Douglas Lake region offers excellent opportunities for the development of research and instruction on the animal parasites."

The scientific possibilities suggested by the flora of the region are discussed by Doctor F. C. GATES in his report to the director as follows:

"Douglas Lake is located in the northern part of the Lower Peninsula of Michigan about 17 miles each from Petoskey, Mackinaw City and Cheboygan on highland 133 feet above Lakes Michigan and Huron. This location in the transition belt between northern coniferous vegetation and central deciduous forest or hardwood vegetation makes this region particularly valuable for the study of conditions thus represented. No other biological station in the United States is favorable for the study of these conditions.

"Glacial deposits were thickly strewn over the entire region, resulting in essentially flat country. Low ridges, occasional hills and small streams and lakes vary the monotony. Of the lakes in the region, Burt Lake is the largest, being about 20 miles in length. Douglas Lake is about 4 miles long and about 2 miles across in the widest part.

"Three conspicuous soil types are well distributed in the region. On the uplands the better class of soils is clayey—the poorer class, sandy. Hardwood or deciduous forests are the normal vegetative cover of the clayey soils and pine forest of the sandy soils. At the present time, following lumbering and devastation by fire, part of the clayey soil and all of the sandy soil is vegetated with aspens. The lowlands of the region are usually bogs and support the bog type of vegetation. Less abundant, but thoroughly characteristic is the vegetation of the lake shores, river banks and the occasional sand dunes found in the region. Thus it is evident that a wide variety of conditions are present in the region. A diversity of work is therefore possible.

"The beech-maple forest, occupying the better soil on the uplands, is quite similar to that occurring throughout the state of Michigan. The characteristic trees are sugar maple, beech, hemlock, and white ash. Several such forests are within 2 to 5 miles of the station but the best forests are along the Jackson and Tindle Lumber Railway some 15 and more miles west of the station.

"The sandy uplands are now occupied by aspens in place of the pine normal to such situations and formerly present. No adequate idea of the original conditions can now be gathered from the vicinity. The nearest that one can get to conditions approaching original is back of the dunes along Lake Michigan in the Big Stone Bay region, about 17 miles west of Mackinaw City. Aspen vegetation is quite typical of a good deal of the state holdings. Considerable experience, valuable information and useful practice with regard to such land may be gathered in the Douglas Lake region. The aspens are rather short lived trees, seldom attaining respectable size. They gain easy access to a region which is burnt over and play their part in making the ground again suitable for the original kinds of trees. Ample testimony of this fact is had on every hand. One has but to note the frequent occurrence of seedlings, naturally occurring, and the ease with which planted seeds develop, to realize that, in the absence of fire which proper protection can reasonably assure, the region

will again become pine. Near Douglas Lake this may be accomplished in 20 to 40 years. Back from the lake under severer conditions it will take longer unless the region is artificially planted.

"The bog type of vegetation is plentifully represented, both in mature form and in developmental stages, within easy access. The bog trees are mostly coniferous. White cedar (arbor vitae), tamarack, spruces, and balsam are all abundant. The ground flora is quite typical and quite "northern." A study of these northern forms is one of the valuable features of the region. Several orchids are found in such situations, together with the interesting insect-catching sundew and pitcher plants.

"In addition to the three prominent types of vegetation mention may be made of interesting plants along the lake shores: Utricularia, with little bladders catching crustaceans and even small insects, and Decodon, with well developed air tissue. The river banks furnish their quota of interesting species. The streams, although small, furnish a wide variety of conditions from slow, sluggish creeks to a rapid mountain stream in Carp Creek near Cecil Bay. The lakes vary in size from very small ones with no outlet, through Burt Lake, the largest of the inland lakes, to Lake Michigan and Lake Huron. Neither of the latter are within access of regular station activities. Very small, but still typical dunes are within the region. Dune work, however, may be supplemented by a trip to the dunes along Lake Michigan.

"With such a diversity of conditions, together with the secondary effects introduced by fire, the dynamic activities of the vegetation are great and permit a very adequate presentation of ecological principles."

Among the problems in plant ecology suggested by the region are: "the development of certain habitats, successional relationships, correlation of vegetation and evaporation, physiological limitations of habitats and species, growth increments under varying conditions, changes in soil and vegetation due to cutting, burning, draining, planting, and seeding."

*Students preparing to teach and teachers now engaged* in teaching *Zoölogy* or *Botany* will find that the courses offered at the station furnish excellent training in methods of biological work in the field and in the comparatively new field of ecological analysis which aims at securing a better understanding of "the general economy of living things," and this better understanding "should be one of the foundations of popular education." The desirability of this broader view of life has been recognized by boards of education while "the introduction of agricultural subjects into elementary and high schools is symptomatic." To meet this demand the University has changed its entrance requirements. The reader is referred to the statement of the entrance requirements in Botany and Zoölogy in the General Catalogue and in the Annual Announcement of the College of Literature, Science, and the Arts.

## GENERAL LIVING CONDITIONS

At a station of this character the general conditions of living are necessarily somewhat unique. However, reasonable comfort, and especially health, are carefully provided for.

**Board and Lodging.**—Tents for the use of the students and staff are pitched near the Station buildings. Each is erected over a permanent frame, and is waterproof, stormproof, and comfortable. Each tent, 14 x 14 ft., accommodates a maximum of four persons and is covered by a fly, provided with a wooden floor, and equipped with mosquito bed-canopies, pail, tub, washstand, pitcher, bowl, table, chairs, lantern, and straw-filled matresses. Stoves will be supplied if needed. Students will provide their own towels and bedding, and those who prefer to do so may bring their own tents. Such tents must be pitched in accordance with the regulations of the Station and all will be subject to inspection.

Space in tents is allotted in advance upon receipt of the reservation fee of eight dollars, or after registration. The attempt is made to place congenial people together. Students will find the tents ready for occupancy, but are expected to care for them personally during the session.

Mrs. Max M. Ellis, Dean of Women, has general supervision of the women's quarters, and is ready at any time to advise women students.

Board at the Station is furnished on the coöperative plan, under the direction of a stewardess approved by the University. She purchases all the supplies, plans the daily menu, and has general supervision of the kitchen and mess tent. It is planned to furnish board at about $5.25 per week. Members of the Station are not permitted to cook their own meals.*

**Health.**—Although the climate and particularly the outdoor life are highly invigorating and conducive to health, nevertheless, should the need arise, any member of the station is entitled to medical attention, without charge, by the staff physician who also inspects and regulates matters pertaining to general sanitation.

The drinking water is entirely safe.

**Recreation.** — After the day's work, opportunities for boating, swimming, and fishing, are within easy reach. Bonfires on the beach and other informal gatherings after supper have proved to be popular diversions. One of the buildings is set aside for social purposes on inclement evenings, although the other laboratories are reserved for those who wish to work. There is no class-work on Saturday afternoons.

* In order to make possible the purchase of supplies at low cash prices, each member of the Station must, on arrival, deposit with the stewardess forty-two dollars in cash or draft. Students leaving before the close of the session will receive full rebate of their unexpended portion, and all excess will be returned to others at the close of the season.

## FACILITIES FOR INSTRUCTION AND RESEARCH

The buildings of the Station include a large and commodious frame laboratory, two smaller log buildings, a tent laboratory, and an aquarium shelter. These are comfortably fitted with the necessary furniture, and are used for recitations, laboratory work, offices, and research. The equipment of the Station includes a large launch, two portable rowboat motors, five rowboats, various types of nets and seines, traps, cameras, field glasses, compound and dissecting microscopes, and accessories, microtome, and a large supply of minor articles. A good working library is provided. Students expecting to use unusual types of apparatus in their research are invited to correspond with the Director, who will give his attention to their needs.

## FEES

Students, except as below, will pay the regular Summer Session fee of $21.00 for the eight weeks and will then be entitled to take courses aggregating eight hours university credit. A charge of $8.00 is made for the use of the scientific equipment. A further charge of $8.00 is made to those students who use the tents provided by the Station. Students may, however, provide their own camp equipment, of such sort as they may chose.

Students not graduates of the University of Michigan who enroll in the Graduate School will pay, in place of the above fee of $21.00, a fee of $26.00. This fee of $26.00 includes the regular matriculation fee of the University and the fee for the current summer session.

## APPLICATION AND REGISTRATION*

Since the total number of students that can be accommodated is limited, *immediate application is necessary to insure admission.* Moreover, as efficient field work can be accomplished only with small numbers, it is desired to limit the students in each class to twelve, although this number may be exceeded if absolutely necessary. Inasmuch as students will be received into these courses in the order of application, it is advisable to notify the Director or the several instructors as early as possible.

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Each course occupies the entire working day assigned to it, and consists of field or laboratory work, supplemented in every case by lectures, recitations, or conferences, and by assigned reading and preparation of reports.

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For full information concerning the requirements for advanced degrees, address the Dean of the Graduate School, Ann Arbor, Michigan.

### Zoology

101. *The Natural History of Vertebrate Animals.*—The course deals chiefly with fishes, amphibians, and reptiles, not with birds (see Course 107), and only incidentally with mammals. As far as possible representatives of all forms of fishes, amphibians and reptiles occurring in the region are collected, identified and studied in both field and laboratory. Particular attention is given to the ecology of the several species and correlated studies of the food, habitats, enemies and interrelations of the various species are made. The general problems of evolution, distribution and taxonomy are considered as opportunity offers. Although most of the work is given in the field, attention to precise methods of observation and to the correct use of data is required.

Thursday. *Two hours credit.* Assistant Professor Ellis.

*Prerequisite*: Elementary collegiate zoölogy.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 101*a*.

103. *The Natural History of Invertebrate Animals with Reference to the Principles of Ecology.*—The course will consist of a careful examination of the typical aquatic habitats of the region. This will involve the collection of forms, the determination of their life histories and structural adaptations and an analysis of the environmental factors, biological and physical, influencing them. In each habitat only those forms will be considered which are of importance in presenting the facts and principles of ecology. Especial attention will be given to analysis of those factors in the lake which make it a suitable abode for organisms. Each student will have actual experience in determining depths, temperature, transparency to light, food content of the water and such other matters as fall within the scope of this analysis. The field work will be supplemented by lectures and conferences, so that at the end of the season the student will have a fairly comprehensive picture of the conditions of aquatic life and how animals are affected by these conditions.

The course is planned particularly for prospective teachers of biology.

Wednesday and Friday. *Four hours credit.* Mr. KOELZ.

*Prerequisite*: Elementary collegiate zoölogy.

This course gives two hours credit to graduates, who may obtain full credit by registration in Course 103*a*.

105. *The Natural History of Insects.*—This course is intended to give the student a general acquaintance with the insects of the region and to afford opportunity for the study of the various forms in their native habitats. Field studies are made of the life histories, habits, and activities of insects belonging to various orders. Emphasis is placed upon the relation of insects to their environment, and upon economic relations. Some work on the morphology and physiology of insects is included. Instruction is given in the approved methods of collecting and preserving insects in all stages of development. Opportunity is afforded to form individual collections of properly determined specimens.

Monday. *Two hours credit.* Assistant Professor ELLIS.

*Prerequisite*: Elementary collegiate zoölogy.

This course gives one hour credit to graduates. Students desiring full credit, must complete extra work, and will register for Course 105*a*.

107. *Ornithology.*—In this course, birds are studied mostly during their breeding season, but in the latter part of the session, there are opportunities for studying early autumnal migration movements. Special attention is given to identification of birds and methods of field study. Bird behavior and especially nesting habits are considered. Lantern slides are used in studying identification characteristics and for illustrating bird behavior. The bird fauna is ample for the course, and it is interesting especially because of the northern

species breeding here under wild conditions. There are conferences when various ornithological topics are discussed.

Saturday morning, and two or three early morning trips to be arranged. *Two hours credit.* Professor STRONG.

*Prerequisite*: An elementary collegiate course in zoölogy, botany or biology.

Course 107 does not give credit to graduates. Those who desire credit, or who wish to carry on further work on birds, may elect either 107*a* or Course 109 with Professor STRONG.

109. *Special and Research Work in Zoölogy.*—Students who do not find under the formally announced courses in zoölogy, work suited to their needs or attainments, may, if properly prepared, elect Course 109. Those qualified to work independently will find numerous problems to engage their attention. Every encouragement in the direction of profitable research and the publication of results will be given. Advanced students as well as independent investigators who can foresee special needs are advised to notify the Director who will endeavor to provide the necessary facilities.

Students who are beginning research, or who work under direction are recommended to choose subjects in the following field:

(a) The Birds. Professor STRONG.
(b) The Fishes or Insects. Assistant Professor ELLIS.
(c) The Parasitic Worms. Assistant Professor LA RUE.

Days to be arranged. *Two, four, six, or eight hours credit.* Assistant Professor LA RUE, Professor STRONG, Assistant Professor ELLIS.

*Prerequisite*: Admission only by permission of the instructors in charge.

This course gives full credit to graduates.

## Botany

102. *Field and Forest Botany.*—Although this course is accepted in lieu of elementary collegiate botany as prerequisite for other courses in botany at the Station, it differs widely both in material and method from the usual beginning course in botany. It may with profit be elected by those who have had a course in elementary botany as well as by those who have had work in zoölogy or biology. The work is given principally in the field and is for the most part concerned with the natural history of the groups best represented in the locality. Students will collect and identify and thus become familiar with the commoner species and will study in the field the trees, aquatics, ferns, insectivorous plants, orchids and some herbaceous plants. Among subjects which will be dealt with are the effect of external factors, such as soil, water and light upon the vegetation, adaptation of plants to winter conditions, cross pollination, and dissemination of seeds. In connection with this course op-

portunity will be afforded college and high school teachers of botany to collect material for use in their classes. Instruction in the preservation of such material will be given to students desiring it.

Tuesday and Thursday. *Four hours credit.* Dr. HOLMAN.

*Prerequisite*: An elementary collegiate course in botany, zoölogy or biology or the equivalent.

This course does not give credit to graduate students.

104. *Systematic Botany.*—The chief aim of this course is to acquaint the student with the flora about the Station and to give him facility in the identification of plants by the Manual. About one hundred species of plants are identified in the field, the characteristics of the more important families of flowering plants are learned, and the general principles of the classification of plants are presented. There is excellent opportunity for the collection and preparation of material for the herbarium. Students who complete this course successfully should be able to identify readily the native flora in any section of the country.

Wednesday. *Two hours credit.* Dr. EHLERS.

*Prerequisite*: Botany 102 at the station or a course in elementary collegiate botany. Courses 102 and 104 may not be taken concurrently.

This course gives one hour of credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 104*a*.

106. *Ecology.*—This course serves as a general introduction to ecological field work and the methods of ecological research, with particular reference to the study of plant associations. Practice is given in the recognition of associations, the determination and description of their structure and successful relations, and the measurement of some environmental factors. Particular attention is given to the dynamic factors of the environment, to their effect on the present structure and future development of the plant community, and to the role of the individual plant in promoting or retarding these effects. Because of the large number of associations in the region, it is impossible to study more than the most important ones. These include the aspen association, the hardwood forest, the tamarack and sphagnum bog, the arbor-vitæ bog, and the sand dunes, lagoons, and beaches along the lake shore.

Tuesday and Thursday. *Four hours credit.* Assistant Professor GATES.

*Prerequisite*: Elementary collegiate botany but it is recommended that the student have had systematic botany and plant anatomy.

This course gives two hours credit to graduate students, who may receive full credit by registration in Course 106*a*.

108. *Plant Anatomy.*—The general facts and principles of plant anatomy are presented by means of material collected and prepared by each student individually. Students thus have practice in the preservation of material, methods of fixation, section cutting, and staining. Every facility will be given for the collection and preservation of material for use in teaching or in research. The topics chiefly considered are the anatomy and secondary thickening of the stem and the structure of the root and the foliage leaf. The modifications of the structure of the leaf in different environments will be considered.

Monday. *Two hours credit.* Dr. HOLMAN, and Assistant

*Prerequisite*: Elementary collegiate botany.

This course gives one hour of credit to graduate students. Such students wishing two hours of graduate credit must perform additional work and will register for Course 108*a*.

110. *Advanced Systematic Botany.*— In the field the student will have practice in the identification and recognition of plants belonging to the more difficult groups, including grasses, sedges, pondweeds, and others, and in the identification of plants from fruit or leaf characters only. The characteristics of these families will be presented both in the field and by lecture. The lectures will also consider the evolution and relationships of the angiosperms, the rules of botanical nomenclature, and the present trend of systematic botany.

Friday. *Two hours credit.* Dr. EHLERS.

*Prerequisite*: Botany 104 at the Station, or Botany 8 at the University, or equivalent preparation elsewhere.

This course gives full credit to graduate students.

112. *Special and Research Work in Botany.*—Students who have taken Courses 104 or 106 or have had adequate botanical experience elsewhere, will find at the Biological Station excellent opportunities for further study or research in many lines of botany. Undergraduates, or graduates beginning research and consequently needing personal direction, are advised to choose a problem along ecological, anatomical, or systematic lines. Advanced students or independent investigators are free to choose problems in any line of botany, and every effort is made to provide them with the necessary facilities and equipment for their work.

Days to be arranged. *Two, four, six, or eight hours credit.* Assistant Professor GATES, Dr. HOLMAN, and Dr. EHLERS.

*Prerequisite*: Admission only by arrangement with the instructors in charge.

This course gives full credit to graduate students.

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